Small Business Innovation Research/Small Business Tech Transfer

Fast-Light Enhanced Fiber Gyroscope, Phase II

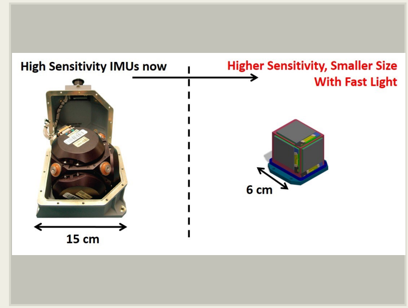
Completed Technology Project (2017 - 2020)

Project Introduction

Current state-of-the-art navigation systems incorporate optical gyroscopes and optical accelerometers as inertial sensors. These devices contain no moving parts and can sense rotations and accelerations with high bandwidth. However, there is a fundamental tradeoff between the size of an optical gyroscope and its sensitivity. Highly sensitive gyroscopes are needed to meet navigation goals, but Size, Weight and Power (SWaP) are extremely precious resources in spacecraft or UAVs. Enhancing the sensitivity of existing devices, reducing their size, or both can allow the use of inertial navigation in smaller airframes, or free up room to include larger mission payloads for scientific or military purposes. Using fast-light effects generated in fiber with Stimulated Brillouin Scattering, we will enhance rotation sensitivity of conventional Ring Laser Gyroscope, to develop IMUs that will deliver higher performance and/or lower SWaP than a traditional navigation system. In Phase I we built, tested, and analyzed an SBS RLG test bed with automated control and data collection, both under quiet conditions and under rotations. We also established requirements on system stability to produce an interesting RLG using the technology, and determined it is technically feasible to achieve in Phase II. In the proposed Phase II work, we will demonstrate fast-light enhancement of an RLG in the lab and produce a prototype to characterize the potential performance of a fast-light enhanced IMU product.

Anticipated Benefits

The improvement of inertial sensor components is essential to support navigation and attitude control systems for future NASA satellite missions. The proposed technology will have significantly reduced size and weight with ruggedized components designed to meet stringent dynamic, mechanical, thermal and radiation specifications for operation in space. A robust, high performance, and cost effective gyroscope suitable for space based operations will also have significant impact on demanding NASA applications that require stabilized platforms for long term space applications in smaller and smaller satellites. In particular, the technology can allow: Tracking and control of launch vehicles for placing payloads into orbital or sub-orbital trajectories. Precision inertial feedback during orbital maneuvers or stationkeeping operations on manned or unmanned spacecraft. Actively stabilize instrument platforms during sensitive astronomical observations or scientific measurements.Self-guided ordinance and unmanned aerial vehicles, where traditional high sensitivity optical INS systems are too large to use. Stabilizing weapons platforms or communications devices mounted on ground and naval vehicles of all sizes. Commercial aircraft and marine vessels commonly use optical inertial measurement devices for navigation, stabilization, and tracking. Accurate navigation and gyrocompasses in a small form factor in the oil and gas industry for well-drilling.



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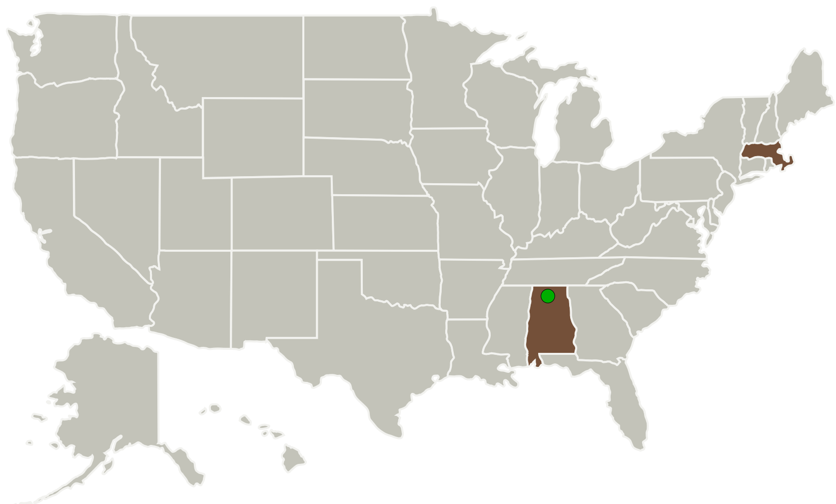
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
MagiQ Technologies, Inc.	Lead Organization	Industry	Somerville, Massachusetts
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Massachusetts

Project Transitions

June 2017: Project Start

June 2020: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141155)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

MagiQ Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

David D Smith
Gwenevere L Jasper

Principal Investigator:

Caleb A Christensen

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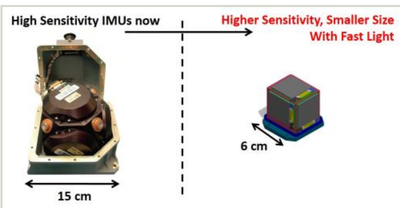
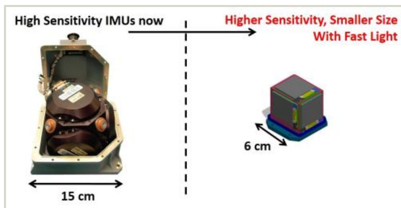
June 2020: Closed out

Closeout Documentation:
- Final Summary Chart PDF*(https://techport.nasa.gov/file/141154)*

Images



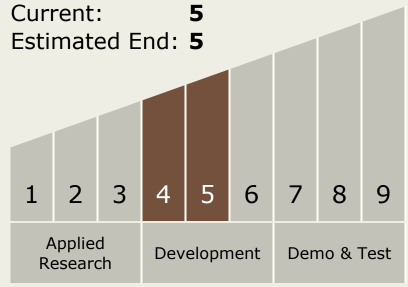
Briefing Chart Image
Fast-Light Enhanced Fiber Gyroscope, Phase II Briefing Chart Image
(https://techport.nasa.gov/image/128450)



Final Summary Chart Image
Fast-Light Enhanced Fiber Gyroscope, Phase II
(https://techport.nasa.gov/image/132183)

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System